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Ressources naturelles Canada

BIOGAS RESOURCE RECOVERY FOR DISTRIBUTED GENERATION

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SCS Energy

DOE/CETC/CANDRA Workshop on Microturbine Applications

January 20-22, 2004 Marina Del Ray, Califonia

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Status of Bio Generation

- Difficult to obtain reasonable contracts for sale of wholesale electric power to utilities
- Retail loads at landfills are relatively small
- Retail loads high at wastewater plants, but limited available fuel low
- Retail rates are still fairly high
- Can exploit high retail rates through distributed generation technology

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Candidate Sites for Retail Deferral

- Large landfill gas flare station
- Water treatment plant
- Leachate or groundwater treatment plant
- MRF or transfer station
- Office complex
- “Over the Fence” User

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Distributed Generation Technologies

- Reciprocating engines
- Microturbines
- Fuel cells
- Stirling cycle engines
- Organic Rankine cycle

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- SCS Engineers – 30 Years of Landfill/Landfill Gas Experience
- SCS Field Services – Operate ~ 150 Landfill Sites
- SCS Energy – Developed Specifically for Distributed Generation

SCS Energy – Experience

(Feasibility Studies, Design, Construct, and Operation, Turnkey)

- Reciprocating Engines (8) – 12 MW (Jenbacher, Deutz)
- Microturbines (55) – 2,710 kW (Ingersoll-Rand-70, Capstone-30)
- Microturbine – 250 kw (Ingersoll-Rand-250)
- Fuel Cell – 250 kW (Fuel Cell Energy)
- Organic Rankine System - 200 kW (UTC)

Case Study
Operating Industries, Inc. (OII) Landfill

- Located in Monterey Park, CA (Los Angeles County)
- Open from 1948 to 1984
- Permitted for liquid waste 1976 (300 million gallons received)
- 30 million tons of waste in place
- Refuse mass over 300 feet thick
- Placed on Superfund list 1986

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LFG Collection and Control System

- 350 vertical extraction wells
- 150 liquid removal pumps
- 40,000 ft. of above-grade PVC LFG collection piping
- Two 4000 scfm flares rated for 99.99% DRE (Destruction & Removal Efficiency)
- 20,000 GPD Leachate Treatment Plant

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Project Motivations

- On-Site power cost of $20 – $30,000 per month
- Less than 5% of available landfill gas required to satisfy on-site power requirements
- State grant funds were available
- Conversion of a wasted energy resource into green power
- Make a contribution to resolution of California power crisis

Ingersoll-Rand Microturbine Selection

- Larger size required less units (6 vs 14)
- Ingersoll-Rand offered a 5-year fixed price maintenance contract
- Ingersoll-Rand was willing to accept operation without siloxane removal

Project Components

- Six 70 kW Ingersoll-Rand microturbines
- 300 scfm/10 psig positive displacement blower
- Refrigeration and reheat modules (chills to 40º F and reheats to 60º F+)
- Exhaust Ducting into the flare combustion air blowers
- Dedicated LFG fuel line
- Switchgear, distibution, & utility metering equipment
- Plant control system for local & remote monitoring, alarming, and start/stop control

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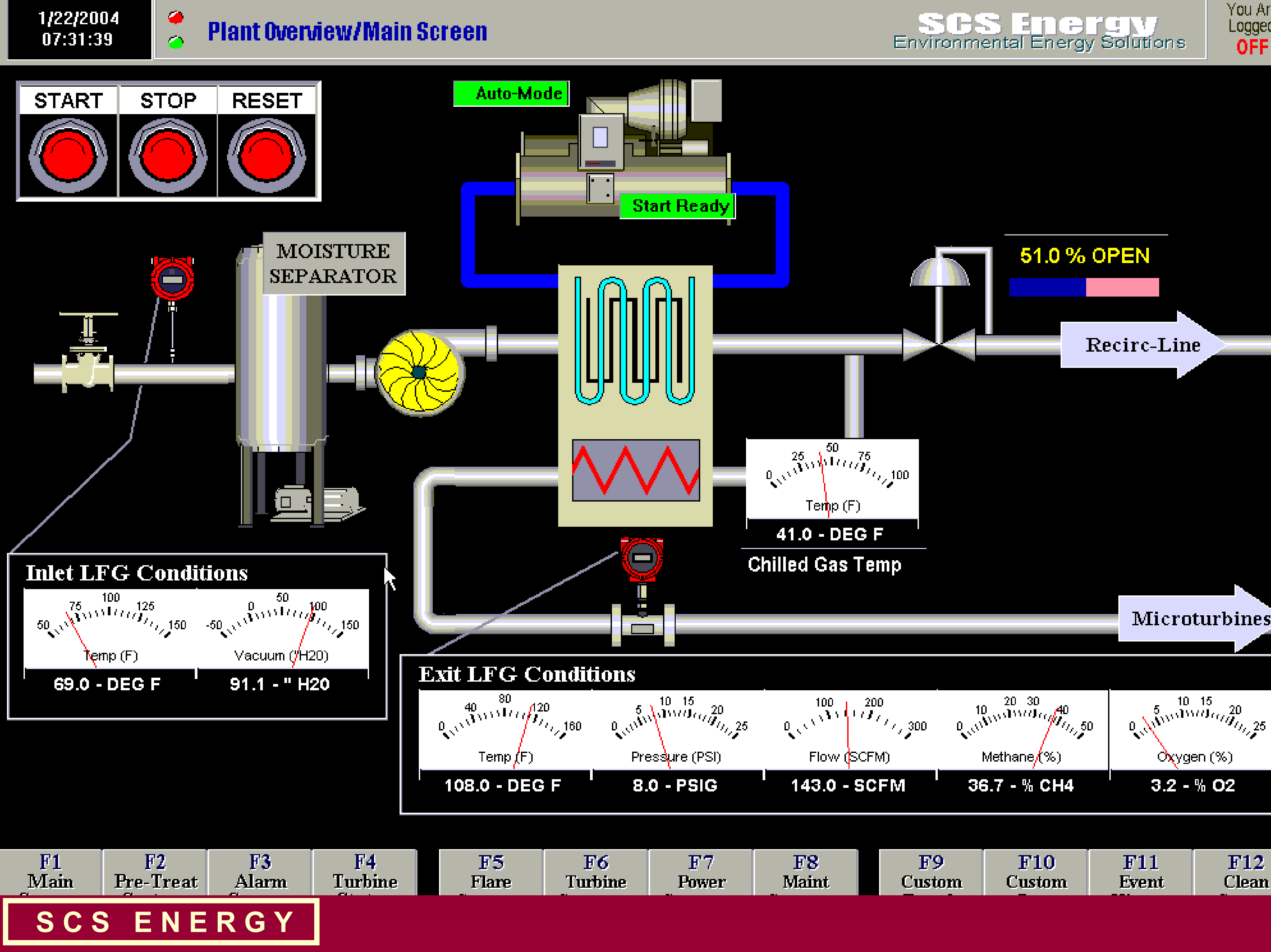

1/22/2004
07:31:39
Plant Overview/Main Screen
SCS Energy
Environmental Energy Solutions
You Ar
Logged
OFF
START
STOP
RESET
Auto-Mode
Start Ready
MOISTURE SEPARATOR
51.0 % OPEN
Recirc-Line
41.0 - DEG F
Chilled Gas Temp
Temp (F)
Microturbines
Inlet LFG Conditions
Temp (F)
Vacuum ("H20)
69.0 - DEG F
91.1 - " H20
Exit LFG Conditions
Temp (F)
Pressure (PSI)
Flow (SCFM)
Methane (%)
Oxygen (%)
108.0 - DEG F
8.0 - PSIG
143.0 - SCFM
36.7 - % CH4
3.2 - % O2
F1 Main
F2 Pre-Treat
F3 Alarm
F4 Turbine
F5 Flare
F6 Turbine
F7 Power
F8 Maint
F9 Custom
F10 Custom
F11 Event
F12 Clean
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PowerWorks


PowerWorks
PowerWorks
PowerWorks

OII Landfill Project Summary

- Capital cost = \$1,300,000 (\$3,095/kW)
- O&M cost = 1.9¢/kWh
- On-site retail deferral at 15¢/kWh
- Interconnection cost = \$105,000 (\$250/kW)
- Design/construction duration = 6 months
- Simple payback (after grants) = 2.0 years

Case Study
Los Angeles County Sanitation District
Calabasas Landfill

- Located in Agoura, CA (Los Angeles County)
- Began disposal operations in 1961
- Landfill currently open and accepting 1,000 tons refuse per day
- 20 million tons of waste in place

LFG Collection and Control System

- 611 vertical extraction wells
- 65,000 linear feet of horizontal collection trench
- 50,000 linear feet of above grade PVC collection piping
- Flare station gas flow 6,000 scfm
- Low gas quality to flare station (< 30% methane)

Project Motivations

- High on-site power cost
- SCAQMD offer of ten 30kW Capstone microturbines
- State grant funds were available
- Less than 3% of available landfill gas required to satisfy on-site power requirements
- Conversion of a wasted energy resource into green power
- Make a contribution to resolution of California power crisis

Microturbine Motivations

- Low on-site power load (flare, irrigation pumps)
- Low methane content in LFG (< 30%)
- Desire for low Nox emissions

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Project Components

- Ten 30 kW Capstone microturbines
- 200 scfm/80 psig compressor
- Refrigeration and reheat modules (chills to 40º F and reheats to 60º F+)
- Graphite-based, activated carbon treatment
- Dedicated LFG fuel line from select wells
- Switchgear, distibution, & utility metering equipment
- Plant control system for local & remote monitoring, alarming, and start/stop control

9/9/2002
10:17:15 AM

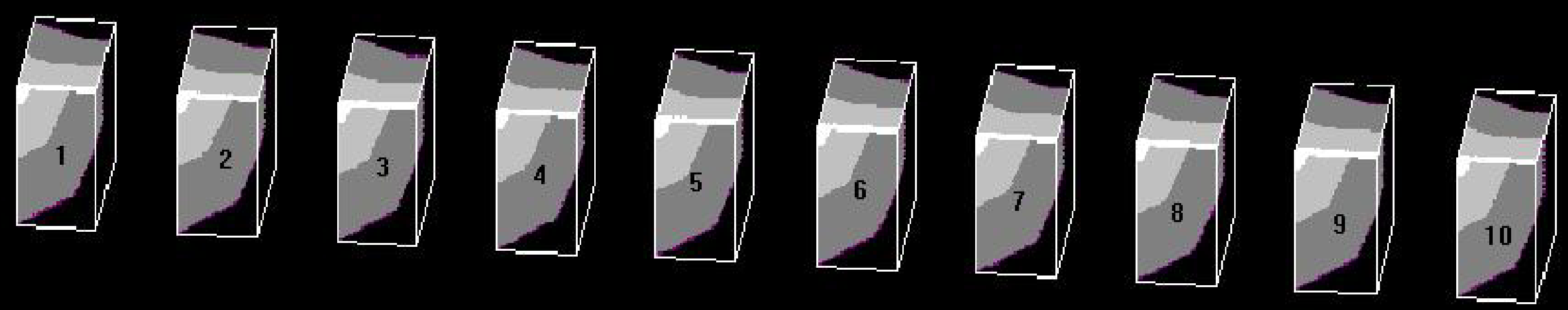
Turbine Summary Screen

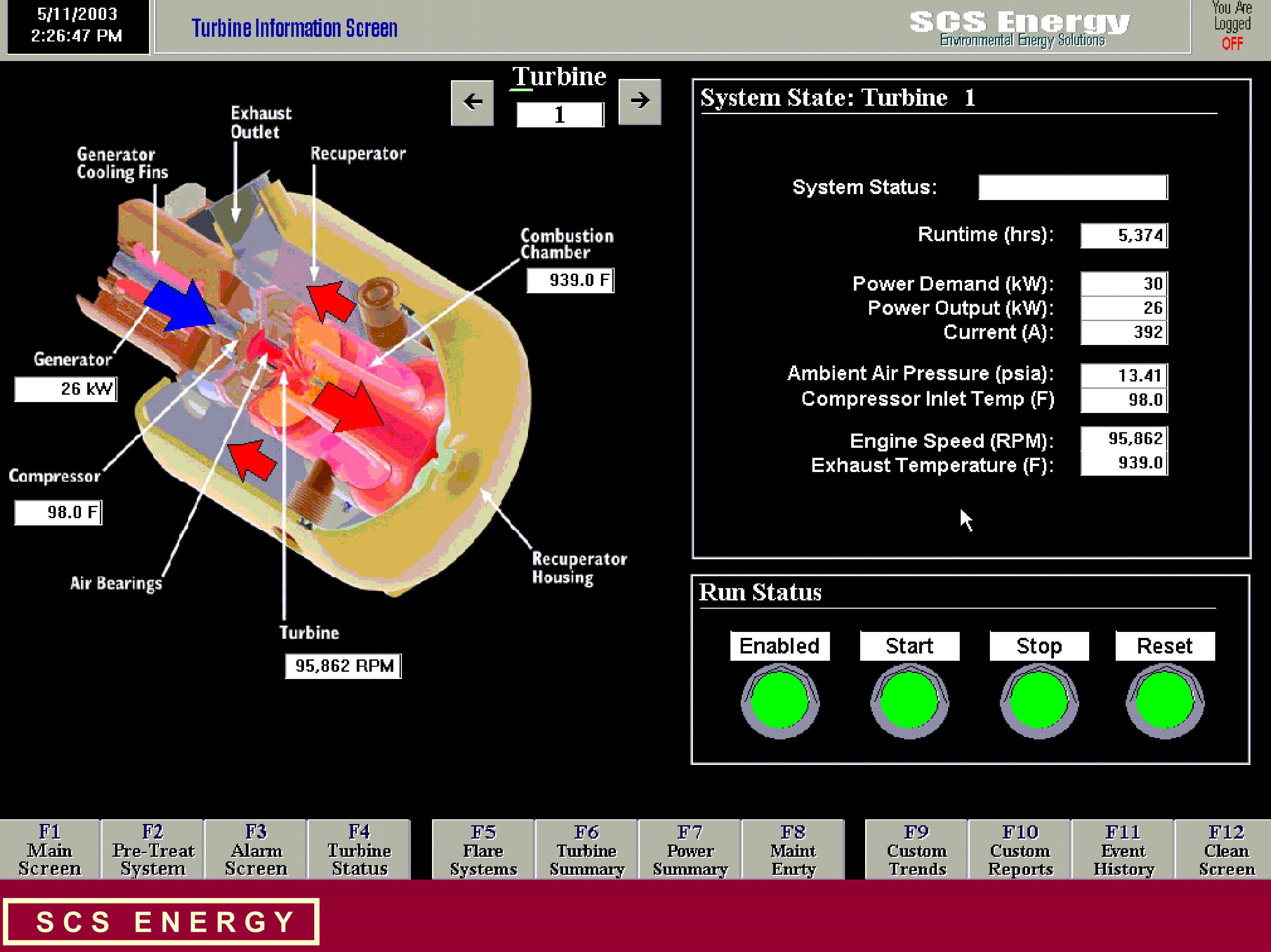
SCS Energy
Environmental Energy Solutions

You Are Logged OFF

Turbine Number:	1	2	3	4	5	6	7	8	9	10
Turbine Enabled:	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
Runtime (hrs):	347	347	347	347	347	347	347	347	347	347
Power Output (kW):	27	26	24	24	25	24	25	26	26	26
Current (A):	850	88	81	81	84	81	85	86	86	86
Ambient Air Pressure (psia):	13	14	14	14	13	13	14	13	14	14
Compressor Inlet Temp (F)	98	98	98	98	98	98	98	98	98	98
Engine Speed (RPM):	96,300	96,090	95,798	95,612	95,862	95,654	95,612	95,924	96,048	96,028
Exhaust Temperature (F):	938	938	938	941	941	939	939	939	938	938

Select the turbine information you would like to highlight





5/11/2003
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Turbine Information Screen
SCS Energy
Environmental Energy Solutions
You Are Logged OFF
Turbine
1
Exhaust Outlet
Generator Cooling Fins
Recuperator
Combustion Chamber
939.0 F
Generator
26 kW
Compressor
98.0 F
Air Bearings
Turbine
95,862 RPM
Recuperator Housing
System State: Turbine 1
System Status:
Runtime (hrs): 5,374
Power Demand (kW): 30
Power Output (kW): 26
Current (A): 392
Ambient Air Pressure (psia): 13.41
Compressor Inlet Temp (F) 98.0
Engine Speed (RPM): 95,862
Exhaust Temperature (F): 939.0
Run Status
Enabled
Start
Stop
Reset
F1 Main Screen
F2 Pre-Treat System
F3 Alarm Screen
F4 Turbine Status
F5 Flare Systems
F6 Turbine Summary
F7 Power Summary
F8 Maint Enrty
F9 Custom Trends
F10 Custom Reports
F11 Event History
F12 Clean Screen
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Calabasas Landfill – Cont.

- Capital cost = \$770,000 (\$2,570/kW)
- O&M cost = 2.5¢/kWh
- Onsite retail deferral at 15¢/kWh
- Interconnection cost = \$5,000 (\$16/kW)
- Design/construction duration = 5 months
- Simple payback (after grants) = 1.6 years

TYPICAL TURNKEY PROJECT TIMELINE

	MONTH					
DESCRIPTION	1	2	3	4	5	6
DESIGN	10 WEEKS					
INTERCONNECTION	12 WEEKS					
ELECTRICAL EQUIPMENT		14 WEEKS				
MECHANICAL EQUIPMENT		16 WEEKS				
SITE WORK					6 WEEKS	
START-UP						2

TYPICAL TURNKEY PROJECT TIMELINE

	MONTH					
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DESIGN	10 WEEKS					
INTERCONNECTION	12 WEEKS					
ELECTRICAL EQUIPMENT						
MECHANICAL EQUIPMENT						
SITE WORK						
START-UP						2

PERMIT !!!

(AIR, SUP, TITLE V, …)

UP TO 40 WEEKS

Advantages
Microturbine Versus Reciprocating Engine

- Lower NO_x emissions (1/10)
- Can operate on lower methane content fuels
- Pre-packaged in small incremental capacities
- Lower maintenance costs – yet to be proven on a long-term basis

Disadvantages
Microturbine Versus Reciprocating Engine

- Higher heat rate / Lower Efficiency
- Higher capital cost
- Less proven technology
- High Pressure Fuel Requirements
- Significant Fuel Pre-treatment Requirements

DESIGN AND OPERATIONAL ISSUES

- COORDINATION
  - FUEL SUPPLY
  - PRE-TREATMENT
  - PRIME MOVER
  - HEAT RECOVERY
- LEVEL OF PRE-TREATMENT
  - TYPE OF COMPRESSION
  - CAPACITY
  - MOISTURE REMOVAL
  - H2S REMOVAL
  - SILOXANE REMOVAL
- CONTROL SYSTEM
- NOISE
- PROTECTIVE RELAY REQUIREMENTS

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Conclusions

- Several emerging technologies are available to support small BioGas projects
- Microturbines are a relatively proven technology
- Stirling Engines may represent the next major advance in cost reduction
- High retail power costs and financial incentives can result in economically feasible projects

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